

CLAIMS

We claim:

1. A fusion protein comprising a first polypeptide of at least 90% identity to a sequence of amino acid residues as shown in SEQ ID NO:2 and comprising a second cytokine polypeptide or fragment thereof, wherein the fusion protein binds a receptor as shown in SEQ ID NO:115.

2. The fusion protein of claim 1, wherein the second polypeptide is selected from the group consisting of IL-2 as shown in SEQ ID NO:111, IL-4 as shown in SEQ ID NO:112, IL-15 as shown in SEQ ID NO:113, and GM-CSF as shown in SEQ ID NO:114.

3. A fusion protein comprising at least four polypeptides, wherein the order of polypeptides from N-terminus to C-terminus are:

a first polypeptide that comprises a sequence of amino acid residues from 41 to 56 of SEQ ID NO: 2;

a first spacer of 6-27 amino acid residues;

a second polypeptide that comprises a sequence of amino acid residues selected from the group consisting of:

(a) IL-2 helix B residues 53-75 of SEQ ID NO: 111;

(b) IL-4 helix B residues 65-83 of SEQ ID NO: 112;

(c) IL-15 helix B residues 84-101 of SEQ ID NO: 113;

(d) GMCSF helix B residues 72-81 of SEQ ID NO: 114; and

(e) amino acid residues 69-84 of SEQ ID NO: 2;

a second spacer of 5-11 amino acid residues;

a third polypeptide that comprises a sequence of amino acid residues selected from the group consisting of:

(a) IL-2 helix C residues 87-99 of SEQ ID NO: 111;

(b) IL-4 helix C residues 95-118 of SEQ ID NO: 112;

(c) IL-15 helix C residues 107-119 of SEQ ID NO: 113;

(d) GMCSF helix C residues 91-102 of SEQ ID NO: 114; and

(e) amino acid residues 92-105 of SEQ ID NO: 2;

a third spacer of 3-29 amino acid residues; and

a fourth polypeptide that comprises a sequence of amino acid residues selected from the group consisting of:

(a) IL-2 helix D residues 103-121 of SEQ ID NO: 111 ;

(b) IL-15 helix D residues 134-157 of SEQ ID NO: 112;

(c) IL-4 helix D residues 134-160 of SEQ ID NO: 113;

(d) GMCSF helix D residues 120-131 of SEQ ID NO: 114; and

(e) amino acid residues 135-148 of SEQ ID NO: 2.

4. A fusion protein comprising at least four polypeptides, wherein the order of polypeptides from N-terminus to C-terminus are:

a first polypeptide that comprises a sequence of amino acid residues selected from a group consisting of:

(a) IL-2 helix A residues 36-46 of SEQ ID NO: 111;

(b) IL-4 helix A residues 29-43 of SEQ ID NO: 112;

(c) IL-15 helix A residues 45-68 of SEQ ID NO: 113;

(d) GMCSF helix A residues 30-44 of SEQ ID NO: 114; and

(e) amino acids residues 41-56 of SEQ ID NO: 2;

a first spacer of 6-27 amino acid residues;

a second polypeptide that comprises a sequence of amino acid residues selected from the group consisting of:

(a) IL-2 helix B residues 53-75 of SEQ ID NO: 111;

(b); IL-4 helix B residues 65-83 of SEQ ID NO: 112;

(c) IL-15 helix B residues 84-101 of SEQ ID NO: 113;

(d) GMCSF helix B residues 72-81 of SEQ ID NO: 114; and

(e) amino acid residues 69-84 of SEQ ID NO: 2;

a second spacer of 5-11 amino acid residues;

a third polypeptide that comprises a sequence of amino acid residues selected from the group consisting of:

- (a) IL-2 helix C residues 87-99 of SEQ ID NO: 111;
- (b) IL-4 helix C residues 95-118 of SEQ ID NO: 112;
- (c) IL-15 helix C residues 107-119 of SEQ ID NO: 113;
- (d) GMCSF helix C residues 91-102 of SEQ ID NO: 114; and
- (e) amino acid residues 92-105 of SEQ ID NO: 2;

a third spacer of 3-29 amino acid residues; and

a fourth polypeptide that comprises a sequence of amino acid residues from 135-148 of SEQ ID NO: 2.

5. A fusion protein according to claim 3, wherein the fourth polypeptide comprises amino acid residues 135-148 of SEQ ID NO: 2.

6. A fusion protein comprising a polypeptide with at least 90% identity to a sequence of amino acid residues as shown in SEQ ID NO:2 from amino acid residues 32-162 and immunoglobulin heavy chain constant region, wherein the fusion protein bind a receptor as shown in SEQ ID NO:115.

7. The fusion protein of claim 6, wherein the polypeptide has at least 95% identity to a sequence of amino acid residues as shown in SEQ ID NO:2 from amino acid residues 32-162.

8. A fusion protein comprising a polypeptide as shown in SEQ ID NO:2 from amino acid residues 32-162 and immunoglobulin heavy chain constant region.

9. A fusion protein comprising a polypeptide as shown in SEQ ID NO:2 from amino acid residues 32-162 and immunoglobulin heavy chain constant region, wherein the immunoglobulin heavy chain is an Fc fragment.